

WHAT IS CLAIMED IS:

1. A cleaning device for cleaning toner from an image carrier that carries a toner image made of toner, comprising:
 - a blade member having an end, wherein the end touches a surface of the image carrier and scraps off toner from the surface;
 - a vibratable member to which the blade member is fixed; and
 - a vibrating unit that vibrates the vibratable member so that the end of the blade member does not curl.
- 10 2. The cleaning device according to claim 1, wherein
 - the blade member has a length, and
 - the blade member is situated such that length of the blade member is parallel to an axis of rotation of the image carrier and the blade member makes an acute angle with a tangent to the surface of the image carrier in a direction of rotation of the image carrier.
- 15 3. The cleaning device according to claim 1, wherein the angle is between 0 degree and 50 degrees.
- 20 4. The cleaning device according to claim 1, wherein the vibratable member presses the blade member against the image carrier.
- 25 5. The cleaning device according to claim 1, further comprising a force imparting unit that imparts pressing force to the vibratable member to thereby press the end of the blade member against the

image carrier.

6. The cleaning device according to claim 1, wherein the vibrating unit is a piezoelectric element.

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7. The cleaning device according to claim 6, wherein the piezoelectric element is plate-like and fixed to the vibratable member.

8. The cleaning device according to claim 7, wherein the 10 piezoelectric element expands and contracts to thereby vibrate the vibratable member.

9. The cleaning device according to claim 7, wherein the 15 piezoelectric element has an electrode, and the electrode is electrically connected to the vibratable member.

10. The cleaning device according to claim 6, wherein the vibratable member has a fixed end and a free end, and the piezoelectric element is fixed to the vibratable member between the fixed end and the free 20 end.

11. The cleaning device according to claim 6, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a laminating direction as d-33 25 direction.

12. The cleaning device according to claim 6, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a face direction as d-31 direction, wherein the face direction is a direction perpendicular to the laminating direction.

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13. The cleaning device according to claim 1, wherein the vibrating unit is fixed to the vibratable member, and the vibratable member is stiffer in a portion where the blade member is fixed than in a portion 10 where the vibrating unit is fixed.

14. The cleaning device according to claim 1, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, and a distance between the end of the blade 15 member and an end of the blade member is between one to two times a thickness of the blade member.

15. The cleaning device according to claim 1, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer 20 than the blade member, the vibratable member having an end, wherein the end of the blade member and the end of the vibratable member are at same level or the end of the blade member protrudes towards the image carrier than the end of the vibratable member.

16. The cleaning device according to claim 1, wherein a plurality of the vibrating units are arranged at predetermined interval along a width of the vibratable member.

5 17. The cleaning device according to claim 16, further comprising a drive circuit that drives the vibrating units.

18. A cleaning device for cleaning toner from an image carrier that carries a toner image made of toner, comprising:

10 a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

15 a vibratable member to which the blade member is fixed; and a vibrating unit that vibrates the vibratable member in such a manner that amplitude of the vibrations is smaller than the specified amount for which the blade member is pressed against the surface of the image carrier.

19. The cleaning device according to claim 18, wherein amplitude of vibration of the end of the blade member is smaller than an average particle size of the toner.

20. The cleaning device according to claim 18, wherein the blade member has a length, and

25 the blade member is situated such that length of the blade

member is parallel to an axis of rotation of the image carrier and the blade member makes an acute angle with a tangent to the surface of the image carrier in a direction of rotation of the image carrier.

5 21. The cleaning device according to claim 18, wherein the angle is between 0 degree and 50 degrees.

22. The cleaning device according to claim 18, wherein the vibratable member presses the blade member against the image carrier.

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23. The cleaning device according to claim 18, further comprising a force imparting unit that imparts pressing force to the vibratable member to thereby press the end of the blade member against the image carrier.

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24. The cleaning device according to claim 18, wherein the vibrating unit is a piezoelectric element.

25. The cleaning device according to claim 24, wherein the
20 piezoelectric element is plate-like and fixed to the vibratable member.

26. The cleaning device according to claim 25, wherein the piezoelectric element expands and contracts to thereby vibrate the vibratable member.

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27. The cleaning device according to claim 25, wherein the piezoelectric element has an electrode, and the electrode is electrically connected to the vibratable member.

5 28. The cleaning device according to claim 24, wherein the vibratable member has a fixed end and a free end, and the piezoelectric element is fixed to the vibratable member between the fixed end and the free end.

10 29. The cleaning device according to claim 24, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a laminating direction as d-33 direction.

15 30. The cleaning device according to claim 24, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a face direction as d-31 direction, wherein the face direction is a direction perpendicular to the laminating direction.

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31. The cleaning device according to claim 18, wherein the vibrating unit is fixed to the vibratable member, and the vibratable member is stiffer in a portion where the blade member is fixed than in a portion where the vibrating unit is fixed.

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32. The cleaning device according to claim 18, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, and a distance between the end of the blade member and an end of the blade member is between one to two times a 5 thickness of the blade member.

33. The cleaning device according to claim 18, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, the vibratable member having an end, wherein 10 the end of the blade member and the end of the vibratable member are at same level or the end of the blade member protrudes towards the image carrier than the end of the vibratable member.

34. The cleaning device according to claim 18, wherein a plurality of 15 the vibrating units are arranged at predetermined interval along a width of the vibratable member.

35. The cleaning device according to claim 34, further comprising a drive circuit that drives the vibrating units.

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36. A cleaning device for cleaning toner from an image carrier that carries a toner image made of toner, comprising:
a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby 25 scrap off toner from the surface;

a vibratable member to which the blade member is fixed; and
a vibrating unit that vibrates the vibratable member in such a
manner that toner that is not in contact with the end of the blade
member is vibrated.

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37. The cleaning device according to claim 36, wherein
the blade member has a length, and
the blade member is situated such that length of the blade
member is parallel to an axis of rotation of the image carrier and the
10 blade member makes an acute angle with a tangent to the surface of
the image carrier in a direction of rotation of the image carrier.

38. The cleaning device according to claim 36, wherein the angle is
between 0 degree and 50 degrees.

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39. The cleaning device according to claim 36, wherein the
vibratable member presses the blade member against the image carrier.

40. The cleaning device according to claim 36, further comprising a
20 force imparting unit that imparts pressing force to the vibratable
member to thereby press the end of the blade member against the
image carrier.

41. The cleaning device according to claim 36, wherein the vibrating
25 unit is a piezoelectric element.

42. The cleaning device according to claim 41, wherein the piezoelectric element is plate-like and fixed to the vibratable member.

43. The cleaning device according to claim 42, wherein the 5 piezoelectric element expands and contracts to thereby vibrate the vibratable member.

44. The cleaning device according to claim 42, wherein the piezoelectric element has an electrode, and the electrode is electrically 10 connected to the vibratable member.

45. The cleaning device according to claim 41, wherein the vibratable member has a fixed end and a free end, and the piezoelectric element is fixed to the vibratable member between the fixed end and 15 the free end.

46. The cleaning device according to claim 41, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a laminating direction as d-33 20 direction.

47. The cleaning device according to claim 41, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a face direction as d-31 direction, 25 wherein the face direction is a direction perpendicular to the laminating

direction.

48. The cleaning device according to claim 36, wherein the vibrating unit is fixed to the vibratable member, and the vibratable member is 5 stiffer in a portion where the blade member is fixed than in a portion where the vibrating unit is fixed.

49. The cleaning device according to claim 36, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer 10 than the blade member, and a distance between the end of the blade member and an end of the blade member is between one to two times a thickness of the blade member.

50. The cleaning device according to claim 36, wherein the vibrating 15 unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, the vibratable member having an end, wherein the end of the blade member and the end of the vibratable member are at same level or the end of the blade member protrudes towards the image carrier than the end of the vibratable member.

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51. The cleaning device according to claim 36, wherein a plurality of the vibrating units are arranged at predetermined interval along a width of the vibratable member.

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52. The cleaning device according to claim 51, further comprising a drive circuit that drives the vibrating units.

53. A process cartridge comprising:

5 an image carrier that carries a toner image made of toner;

and

a cleaning unit having

a blade member having an end, wherein the end touches a surface of the image carrier and scraps off toner from the surface;

10 a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member so that the end of the blade member does not curl.

15 54. A process cartridge comprising:

an image carrier that carries a toner image made of toner;

and

a cleaning unit having

a blade member having an end, wherein the end is

20 pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member in

25 such a manner that amplitude of the vibrations is smaller than the

specified amount for which the blade member is pressed against the surface of the image carrier.

55. A process cartridge comprising:

5 an image carrier that carries a toner image made of toner;

and

a cleaning unit having

a blade member having an end, wherein the end is

pressed against a surface of the image carrier for a specified amount to

10 thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member in

such a manner that toner that is not in contact with the end of the blade

15 member is vibrated.

56. An image forming apparatus comprising:

an image carrier that carries a toner image made of toner; and

a cleaning unit having

20 a blade member having an end, wherein the end touches

a surface of the image carrier and scraps off toner from the surface;

a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member so

25 that the end of the blade member does not curl.

57. An image forming apparatus comprising:
an image carrier that carries a toner image made of toner; and
a cleaning unit having
a blade member having an end, wherein the end is
5 pressed against a surface of the image carrier for a specified amount to
thereby scrap off toner from the surface;
a vibratable member to which the blade member is fixed;
and
a vibrating unit that vibrates the vibratable member in
10 such a manner that amplitude of the vibrations is smaller than the
specified amount for which the blade member is pressed against the
surface of the image carrier.

58. An image forming apparatus comprising:
15 an image carrier that carries a toner image made of toner; and
a cleaning unit having
a blade member having an end, wherein the end is
pressed against a surface of the image carrier for a specified amount to
thereby scrap off toner from the surface;
20 a vibratable member to which the blade member is fixed;
and
a vibrating unit that vibrates the vibratable member in
such a manner that toner that is not in contact with the end of the blade
member is vibrated.

59. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

an image carrier that carries a toner image made of toner;

a charging unit that electrically charges the image carrier;

5 a developing unit that develops the toner images on the image carries;

a transfer unit that transfers the developed toner image onto a recording medium; and

a cleaning unit having

10 a blade member having an end, wherein the end touches a surface of the image carrier and scraps off toner from the surface;

a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member so

15 that the end of the blade member does not curl.

60. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

an image carrier that carries a toner image made of toner;

20 a charging unit that electrically charges the image carrier;

a developing unit that develops the toner images on the image carries;

a transfer unit that transfers the developed toner image onto a recording medium; and

25 a cleaning unit having

a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed;

5 and

a vibrating unit that vibrates the vibratable member in such a manner that amplitude of the vibrations is smaller than the specified amount for which the blade member is pressed against the surface of the image carrier.

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61. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

an image carrier that carries a toner image made of toner;

a charging unit that electrically charges the image carrier;

15 a developing unit that develops the toner images on the image carries;

a transfer unit that transfers the developed toner image onto a recording medium; and

a cleaning unit having

20 a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed;

and

25 a vibrating unit that vibrates the vibratable member in

such a manner that toner that is not in contact with the end of the blade member is vibrated.

62. An image forming apparatus, in which a latent image is formed on an image carrier, the latent image is developed with a toner having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer (FPIA), the toner image is transferred onto a recording medium, the image forming apparatus comprising:

a blade member having an end, wherein the end touches a surface of the image carrier;

a vibratable member to which to the blade member is fixed; and

a vibrating unit that, after the toner image is transferred onto the recording medium, vibrates the vibratable member so that the end of the blade member vibrates to thereby clean toner remaining on the image carrier.

63. The image forming apparatus according to claim 62, wherein the toner is produced by a polymerization method.

20 64. The image forming apparatus according to claim 62, wherein the end of the blade member is formed with a material having less affinity for the toner than other portion of the blade member.

65. The image forming apparatus according to claim 62, wherein an external additive is added to the toner, and the first end of the blade member is formed with a material having less affinity for the external additive than other portion of the blade member.

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66. The image forming apparatus according to claim 62, wherein amplitude of vibrations of the end of the blade member is smaller than an average particle size of the toner.

10 67. The image forming apparatus according to claim 62, wherein amplitude of vibrations of the end of the blade member can be set as desired.

15 68. The image forming apparatus according to claim 67, further comprising an amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

69. The image forming apparatus according to claim 62, wherein the vibrating unit is a piezoelectric element.

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70. The image forming apparatus according to claim 69, further comprising a voltage applying unit that applies an alternating voltage to the piezoelectric element.

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71. The image forming apparatus according to claim 62, further comprising an amplitude controlling unit that changes amplitude of vibrations of the end of the blade member when the toner image is being formed and when toner image is not being formed.

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72. The image forming apparatus according to claim 62, further comprising an amplitude controlling unit that changes amplitude of vibrations of the end of the blade member based on at least one of an amount of toner deposited on the image carrier, number of images 10 formed, environmental conditions, and an amount of toner replenished.

73. A cleaning device comprising:

a blade member having an end, wherein the end touches a surface of a image carrier that carries a toner image made of toner

15 having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer;

a vibratable member to which the blade member is fixed; and

a vibrating unit that vibrates the vibratable member so that the end of the blade member vibrates to thereby clean the toner on the 20 image carrier.

74. The cleaning device according to claim 73, wherein the toner is produced by a polymerization method.

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75. The cleaning device according to claim 73, wherein the end of the blade member is formed with a material having less affinity for the toner than other portion of the blade member.

5 76. The cleaning device according to claim 73, wherein an external additive is added to the toner, and the end of the blade member is formed with a material having less affinity for the external additive than other portion of the blade member.

10 77. The cleaning device according to claim 73, wherein amplitude of vibrations of the end of the blade member is smaller than an average particle size of the toner.

78. The cleaning device according to claim 74, wherein amplitude of vibrations of the end of the blade member can be set as desired.

15 79. The cleaning device according to claim 75, wherein amplitude of vibrations of the end of the blade member can be set as desired.

80. The cleaning device according to claim 76, wherein amplitude of vibrations of the end of the blade member can be set as desired.

20 81. The cleaning device according to claim 77, wherein amplitude of vibrations of the end of the blade member can be set as desired.

82. The cleaning device according to claim 78, further comprising an amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

5 83. The cleaning device according to claim 79, further comprising an amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

10 84. The cleaning device according to claim 80, further comprising an amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

15 85. The cleaning device according to claim 81, further comprising an amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

86. The cleaning device according to claim 73, wherein the vibrating unit is a piezoelectric element.

20 87. The cleaning device according to claim 86, further comprising a voltage applying unit that applies an alternating voltage to the piezoelectric element.

88. A process cartridge comprising:

an image carrier that carries a toner image made of toner;

and

a cleaning unit having

5 a blade member having an end, wherein the end touches a surface of a image carrier that carries a toner image made of toner having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer;

a vibratable member to which the blade member is fixed;

10 and

a vibrating unit that vibrates the vibratable member so that the end of the blade member vibrates to thereby clean the toner on the image carrier.

15 89. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

an image carrier that carries a toner image made of toner;

a charging unit that electrically charges the image carrier;

a developing unit that develops the toner images on the image

20 carrier;

a transfer unit that transfers the developed toner image onto a recording medium; and

a cleaning unit having

a blade member having an end, wherein the end touches

25 a surface of a image carrier that carries a toner image made of toner

having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer;

5 a vibratable member to which the blade member is fixed;
and

10 a vibrating unit that vibrates the vibratable member so that the end of the blade member vibrates to thereby clean the toner on the image carrier.

90. An image forming apparatus, in which a toner image is formed
10 on an image carrier with a toner having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer (FPIA), the image forming apparatus comprising:

15 a cleaning unit that includes
a blade member having an end, wherein the end touches
a surface of the image carrier;
20 a vibratable member to which the blade member is fixed;
and
a vibrating unit that vibrates the vibratable member so that the end of the blade member vibrates to thereby clean toner
25 remaining on the image carrier,
wherein friction between the image carrier and the blade member is less when the vibrating unit vibrates the vibratable member than when the vibrating unit does not vibrate the vibratable member.

91. The image forming apparatus according to claim 90, further comprising a friction detection unit that detects the friction between the image carrier and the blade member.

5 92. The image forming apparatus according to claim 91, further comprising a friction detection unit that detects the friction based on detection of a rotational torque of the image carrier.

10 93. The image forming apparatus according to claim 91, further comprising a friction detection unit that detects the friction based on detection of a drive current of a motor that drives the image carrier.

15 94. The image forming apparatus according to claim 91, further comprising a friction control unit that controls the friction by controlling the friction.

95. The image forming apparatus according to claim 92, further comprising a friction control unit that controls the friction by controlling the rotational torque.

20 96. The image forming apparatus according to claim 93, further comprising a friction control unit that controls the friction by controlling the drive current.

25 97. The image forming apparatus according to claim 94, wherein the friction control unit electrically controls the friction.

98. The image forming apparatus according to claim 95, wherein the friction control unit electrically controls the rotational torque.

99. The image forming apparatus according to claim 96, wherein the
5 friction control unit electrically controls the drive current.

100. The image forming apparatus according to claim 90, wherein the
vibrating unit is a piezoelectric element.

10 101. The image forming apparatus according to claim 90, wherein the
vibrating unit vibrates the vibratable member in accordance to area of
the toner image.

102. A cleaning device comprising:

15 a blade member having a first end and a second end, wherein
the first end touches a surface of an image carrier that carries a toner
image made of toner;

a vibratable member to which the second end of the blade
member is fixed; and

20 a vibrating unit that vibrates the vibratable member so that the
first end of the blade member vibrates to thereby clean the toner from
the surface of the image carrier,

wherein friction between the image carrier and the blade
member is less when the vibrating unit vibrates the vibratable member
25 than when the vibrating unit does not vibrate the vibratable member.

103. The cleaning device according to claim 102, wherein the vibrating unit vibrates the vibratable member in accordance with the frictional.

5 104. The cleaning device according to claim 102, wherein the vibrating unit vibrates the vibratable member in accordance with any one of a rotational torque of the image carrier and a drive current of the motor that rotates the image carrier.

10 105. The cleaning device according to claim 102, wherein the vibrating unit is a piezoelectric element.

106. The cleaning device according to claim 102, wherein the vibrating unit vibrates the vibratable member in accordance with area of 15 the toner image.

107. A process cartridge comprising:

an image carrier that carries a toner image made of toner;

and

20 a cleaning unit having

a blade member having a first end and a second end,

wherein the first end touches a surface of an image carrier that carries a toner image made of toner;

a vibratable member to which the second end of the

25 blade member is fixed; and

a vibrating unit that vibrates the vibratable member so that the first end of the blade member vibrates to thereby clean the toner from the surface of the image carrier,

wherein friction between the image carrier and the blade member is less when the vibrating unit vibrates the vibratable member than when the vibrating unit does not vibrate the vibratable member.

108. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

10 an image carrier that carries a toner image made of toner; a charging unit that electrically charges the image carrier; a developing unit that develops the toner images on the image carrier;

15 a transfer unit that transfers the developed toner image onto a recording medium; and

a cleaning unit having

a blade member having a first end and a second end, wherein the first end touches a surface of an image carrier that carries a toner image made of toner;

20 a vibratable member to which the second end of the blade member is fixed; and

a vibrating unit that vibrates the vibratable member so that the first end of the blade member vibrates to thereby clean the toner from the surface of the image carrier,

25 wherein friction between the image carrier and the blade

member is less when the vibrating unit vibrates the vibratable member than when the vibrating unit does not vibrate the vibratable member.

109. A method of cleaning toner remaining on an image carrier,
5 wherein the toner having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer, comprising:

fixing a blade member, having an end, to a vibratable member such that the end of the blade member touches the image carrier; and

vibrating the vibratable member so that the end of the blade

10 member vibrates to thereby clean the toner on the image carrier.

110. The method according to claim 109, wherein the toner is produced by a polymerization method.

15 111. The method according to claim 109, wherein the first end of the blade member is formed with a material having less affinity for the toner than other portion of the blade member.

112. The method according to claim 109, wherein the vibrating unit is
20 a piezoelectric element.

113. The method according to claim 112, further comprising applying an alternating voltage to the piezoelectric element.

114. The method according to claim 109, further comprising:
changing amplitude of vibrations of the end of the blade member
when the toner image is being formed and when toner image is not
being formed.

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115. The method according to claim 109, further comprising:
changing amplitude of vibrations of the end of the blade member
based on at least one of an amount of toner deposited on the image
carrier, number of images formed, environmental conditions, and an
10 amount of toner replenished.